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Stud. Hist. Phil. Sci. 35 (2004) 707–727

Studies in History and Philosophy of Science

www.elsevier.com/locate/shpsa

Atoms, complexes, and demonstration: *Posterior analytics* 96b15-25

Owen Goldin

Department of Philosophy, Marquette University, Milwaukee, WI 53201-1881, USA

Received 14 July 2003; received in revised form 20 April 2004

Abstract

There is agreement neither concerning the point that is being made in *Posterior analytics* 96b15–25 nor the issue Aristotle intends to address. There are two major lines of interpretation of this passage. According to one, sketched by Themistius and developed by Philoponus and Eustratius, Aristotle is primarily concerned with determining the definitions of the infimae species that fall under a certain genus. They understand Aristotle as arguing that this requires collating definitional predictions, seeing which are common to which species. Pacius, on the other hand, takes Aristotle to be saying that a genus is studied scientifically through first determining the infimae species that fall under that genus. This interpretation attributes to Aristotle a distinction between primary and derivative subjects. I argue for Pacius's interpretation, defending it against Barnes's objections.

Keywords: Demonstration; Definition; Aristotle; Species; Principles

1. Introduction

Like much of the philosophy of science presented in the *Posterior analytics*, *APo*. 2.13 96b15–25 is concise to the point of near unintelligibility. There is agreement neither concerning the point that Aristotle is making nor the issues that he intends to address.[1] There are two reasons why the passage is so obscure. First, as in much

E-mail address: Owen.Goldin@Marquette.edu (O. Goldin).

[1] Thus Barnes (1994), p. 242, has written, 'The section is exceedingly difficult: even its overall purpose is obscure'.

doi:10.1016/j.shpsa.2004.04.001

of the *APo*., Aristotle uses technical language. But the terms that he uses have multiple senses, and there are not enough clues to clearly determine which sense any of them have. Second, the passage appears to be out of context. Again this is not unusual for the *APo*., much of which appears to be a sheaf of unrelated notes. But because the passage is so difficult, commentators have strained to find ways to link the passage to what is discussed in what precedes and follows: the hunt for definitions. As we shall see, what results is a family of interpretations that are endorsed by most commentators. I believe that these are mistaken. In the present paper I show why this is so, how the passage is to be interpreted, and why this is important.

I shall argue that most commentators are wrong in taking the passage to concern the use of the method of division to determine the definitions of the infimae species falling under a genus. Rather, Ross is correct in taking the passage to lay out the explanatory relations that hold among the definitions of simple subjects and those predicates that are demonstrated to hold of composite subjects, built out of the simple ones.[2] In Goldin (1996) I have argued at length that the clarification of the relations between simple subjects, composite subjects, and their *kath' hauta sumbebēkota* (demonstrable attributes) is a main theme of *APo*. 2.8–10. I have shown how Aristotle there distinguishes between simple subjects, which are the proper subject matter of the sciences, and derivative subjects, which are identified with the demonstrated attributes, which are studied by determining how they follow from the definitions of the simple subjects. I believe that the same point is being made here. The passage confirms the interpretation I have put forward of 2.8–10.

I begin by presenting an interpretation-free translation, and indicating the terminological ambiguities on which a choice of interpretation must rest. I then take up each of these points in turn, and argue for my interpretation. I then review without supporting argument what I take to be the gist of 2.8–10, and show how Aristotle is making much the same point here. I conclude with both a full translation and a paraphrase, which show how the text is to be understood.

2.

APo. 2.13 96b15–25 is as follows:

Χρὴ δέ, ὅταν ὅλον τι πραγματεύηταί τις, διελεῖν τὸ γένος ἐις τὰ ἄτομα τῷ εἴδει τὰ πρῶτα, οἷον ἀριθμὸν εἰς τριάδα καὶ δυάδα, εἶθ° οὕτως ἐκείνων ὁρισμοὺς πειρᾶσθαι λαμβάνειν, οἷον εὐθείας γραμμῆς καὶ κύκλου, καὶ ὀρθῆς γωνίας, μετὰ δὲ τοῦτο λαμβόντα τί τὸ γένος, οἷον πότερον τῶν ποσῶν ἢ τῶν ποιῶν, τὰ ἴδια πάθη θεωρεῖν διὰ τῶν κοινῶν πρώτων. τοῖς γὰρ συντιθεμένοις ἐκ τῶν ἀτόμων τὰ συμβαίνοντα ἐκ τῶν ὁρισμῶν ἔσται δῆλα, διὰ τὸ ἀρχὴν εἶναι πάντων τὸν ὁρισμὸν καὶ τὸ ἁπλοῦν καὶ τοῖς ἁπλοῖς καθ' αὑτὰ ὑπαρχειν τὰ συμβαίνοντα μόνοις, τοῖς δ° ἄλλοις κατ' ἐκεῖνα.

[2] Ross (1949), pp. 654, 657–659.

The following translation steers clear of commitment on any controversial point, and as such is unintelligible:

> When someone is dealing with a certain whole, one must divide the genus into the primary things that are atomic in kind. For example, one must divide number into triad and dyad, and then in this way one must try to get the definitions of them. For example, one must try to get the definitions of straight line, circle, and of right angle. After this, when one has got what the genus is, whether, for example, it is among the quantities or qualities, one must study the proper attributes through the things that are primary and common. For the predicates of the complexes put together from the atoms will be clear from the definitions, on account of the fact that definition and the simple is the principle of all things and on account of the fact that the predicates belong in themselves to the simples alone, and to the other things on account of them.

There are four issues preliminary to determining the general sense of the passage:

1. What does it mean to divide the kind under consideration into the primary things atomic in kind?
2. What are the proper attributes?
3. What are the things that are primary and common?
4. What are the predicates that belong in themselves?

3.

1) What does Aristotle mean when he tells us that, when dealing with some whole, one must divide the kind under consideration into the primary things atomic in kind?

However we interpret the details of the passage, Aristotle is discussing how to 'get definitions' and 'study attributes'. Definitions are the principles of demonstration. Hence at least part of what Aristotle is discussing is the securing of the principles of demonstration. Throughout the *APo.*, Aristotle has stressed that different sciences deal with different kinds of things, and that for each kind of thing there is a different set of first principles.[3] We note that Aristotle tells us that his comments pertain to when 'someone is dealing with a certain whole'. The 'whole' which is relevant in the process of securing first principles is either the genus with which a certain science is concerned, or, less plausibly, the body of facts, observations, and insights that are to be systematically ordered by means of this science. Nothing philosophical hinges on this interpretation of 'whole', since Aristotle takes the identity of a single science to be determined by the single genus with which that science is concerned. To deal with the whole set of not-yet-ordered facts which concern a single science is to deal with the genus which is that science's subject matter.

[3] See especially 1.7, 1.10 76a37–b5, 1.28.

It is in this context that one must concern oneself with the ‘primary things atomic in kind’ (*eidos*). Although *eidos* can in isolation refer to a genus at a any level of universality, when used in proximity to *genos*, it refers to a kind falling under some other kind, which is referred to as a *genos* (Balme, 1962). So here, the kinds in regard to which we identify the primary atoms are species falling under the genus that determines the scope of the scientific inquiry at hand.

Concerning these primary entities, we are told: 1) They are atomic, that is, indivisible.[4] This means that they are without discrete parts that exist as such apart from one another. 2) They are the foundation for the study of the ‘proper attributes’. 3) Complexes are built up from them. We are told that these same complexes are studied on the basis of certain definitions. When Aristotle says that ‘the definition and the simple is the principle of all things’ he is possibly identifying definitions and simples (where ‘definition’ must be understood as what is identified in those linguistic entities that are principles of demonstration and are also called definitions).[5] Though much is yet unclear, we can see the Aristotle wants to identify the simples and the atoms, and also those entities whose definitions are the first principles on the basis of which certain facts about ‘complexes’ are somehow built up from the simples.

The distinction between atoms and things compounded of them reminds us of 1.28 87a38–39: ‘A single science is one pertaining to a single genus—all of those things that are compounded of the primary things and are *kath’ hauta* parts or attributes of these’.[6] Here, to be sure, Aristotle identifies the genus of a science with compounds and attributes, not simples or the subjects of attributes. But other passages of the *APo*. clearly distinguish the genus with which a science deals and the attributes of the genus that are made intelligible by virtue of that science (1.7 75a32–b3, 1.10 76b11–16, 21–22). We can forgive Aristotle the compression of language here which does not make clear the relation between the genus, the complexes, and the attributes. 87a38–39 is important because of its distinction between simple subjects on the one hand and complex subjects and attributes, on the other. We can at least tentatively identify these complex entities and the *kath’ hauta* parts or attributes of the simple entities. But on account of the exceeding concision of his

[4] It is not clear what mode of being split or divided is denied of the atoms. Our examples of atoms are triad, dyad, straight line, circle, and right angle. Although the details are unclear, Aristotle identifies these as basic from the standpoint of the mathematical sciences, even though any particular dyad or line admits of spatial division. In regard to the why dyad and triad are principles of arithmetic, the science of number, it should be remarked that Aristotle is explicit that a unit is not a number but the measure or number (*Meta.* N.1 1088a4–8). But two, unlike one, will fall under the genus of number, and only given another basic subject (three) can all other numbers be generated as complexes built on the simples. (Admittedly this is hard to reconcile with *APo*. 1.10 76b3–5; Aristotle’s thoughts on the matter may not have been settled.) Likewise, the existence and nature of lines is basic in geometry (1.10 76b5); the line segments into which they can be divided are not more basic from a geometrical point of view.

[5] See Smyth (1956), 2869a: ‘καὶ often = *namely*, *for example, and so* where an antecedent statement is explained either by another word or by an example’.

[6] Barnes (1994), p. 243.

language it is still unclear as to exactly what sort of entities Aristotle is referring. What are the simples? What are the complexes and attributes?

Two general ways of answering this question have emerged in the tradition of *Posterior analytics* scholarship. Each interprets 'primary things that are atomic in kind' in a different manner. The dative τῷ εἴδει can be taken to modify τὰ ἄτομα or τὰ πρῶτα. That is to say, the 'primary things that are atomic in kind' can be a) those kinds that, among all of the kinds that are not such as can be further divided and split, are primary; or b) indivisible items which are to be ranked first among all of those items that are grouped or regarded in respect to some kind.

a) The simplest way of understanding 'the primary things that are atomic in kind' is to take them as referring to species that are unsplittable insofar as they cannot be subdivided into any more particular species. On this reading, the passage in question begins with the sensible suggestion that the first step in developing a science dealing with some genus is to determine the infimae species falling under that genus. But there are problems with this interpretation. It ill fits the examples that Aristotle gives. Perhaps 'straight line', 'circle', and 'right angle' can plausibly be take to be among a determinate number of basic kinds in geometry. But could Aristotle be exhorting us to list and clarify individual numbers as the basic kinds of arithmetic? The list would go well beyond Aristotle's examples of two and three; there would be an infinite number of such numbers, all of which would need to be distinguished through the process of division, prior to scientific clarification of the genus number. In order to avoid this result, one must say that according to Aristotle's arithmetic theory, all numbers derive from the numbers two and three, in such a manner that all arithmetical proofs are ultimately grounded in the definitions of these numbers as first principles. This is the suggestion of Pacius.[7] Predictably, the details remain murky, but that does not speak against its credentials as an authentically Aristotelian teaching, since in principle the science of numbers cannot be formalized according to the structures laid down in the *Posterior analytics*.[8]
b) An alternative would be to take the atoms here not to be the basic kinds, but the basic *terms* that are employed in defining the kinds. Such terms would be unsplittable insofar as they are not defined on the basis of more basic terms. They are primary insofar as they are underived; on this account, then, 'primary' and 'atomic' are here synonymous. On this interpretation, many terms are composites, and to define such a term is to analyze it in an account of the simple or atomic elements that make it up. This distinction between atoms and complexes corresponds to our distinction between primitive and derived terms.

This is the line of interpretation favored by Barnes. He recognizes that at 96b16 'atom' must refer to an infima species, but argues that it cannot have this sense at

[7] Pacius (1966), pp. 334–335.
[8] See Mueller (1974), pp. 37–57.

96b21. 'For it is hard to refer "the items compounded from the atoms" to the higher genera; it is impossible to suppose that attributes "hold of the other things in virtue of" their holding of an *infima species*'.[9] The first objection, however, presupposes that what is compounded from the atoms are genera; that the sort of composition here is simply adding together the extensions of the species. I shall advocate both an alternative account of the nature of the composition of the atoms, and shall argue that according to Aristotle's theory it is indeed the case that the attributes of complex subjects are caused by, and are to be explained by, the natures of the simple subjects.

What positive arguments favor Barnes's interpretation? Does the *Posterior analytics* contain other indications of the distinction between primitive and derived terms? Barnes points to 1.10 76a32 and 1.28 87a38–39. In the first passage Aristotle says that of the things treated by a given science, the primary things and those from them have their *ti sēmainei* (what it means) assumed, and that while the being of the primary things is assumed, it is proven for the others. In the second passage, Aristotle identifies the in itself parts or attributes of a kind as what comes from certain primitives. Here, as at 1.1 71a17–25, Aristotle speaks of how a science assigns certain explanatory roles to both the being and the meaning of a certain item. It is linguistic entities, terms, that have meaning, and extralinguistic entities that, in the context of the sciences, are said to have being. Hence, as is sometimes the case in the *Organon*, there is no way to avoid attributing to Aristotle a use/mention confusion.[10] This can be disentangled, but doing so is not straightforward. At issue is whether we are to take Aristotle as sloppily distinguishing between two kinds of linguistic entities (so that primitive terms denote those beings whose existence is assumed and derived terms denote those beings whose existence is demonstrated), or two kinds of entities, basic and derivative subjects, the second of which are not defined through the first principles of a science, although the meaning of terms referring to them is laid out in a nominal definition. If we interpret Aristotle as making the first distinction, we attribute to him a kind of linguistic foundationalism, according to which certain meanings are basic and others built up from them, as laid out in the definitions of those other terms. Aristotle nowhere clearly advocates such a linguistic foundationalism, and his later writings, at any rate, are incompatible with it. In *Meta*. Z.12 1038a18–25 Aristotle tells us that a differentia refers to the same simple as the whole definition, insofar as the differentia already implies the genus under which it falls. Hence the meaning of the species term is not simply a conjunction of the meanings of the terms present in its definition. For these reasons, I take note of this possible interpretation of 'atoms' but do not pursue it further. Instead, I endorse the second interpretation, according to which Aristotle distinguishes between two kinds of beings: simples, of which a science assumes both the essence and being, and complex entities, of which a science assumes a nominal definition of the term that refers to

[9] Barnes (1994), p. 243.
[10] On this see, for example, Ackrill (1978), pp. 71, 75; Furth (1988), pp. 11–12.

them and demonstrates the existence. As I discuss below, this distinction is central to the *APo.*, as I understand it.

2) At 96b20 Aristotle tells us that once one has divided the genus into simples, defined the simples (which will among other things involve determining the category to which their genera belong)[11] and determined the genus to which a certain kind belongs, one must study the proper *pathē* on the basis of 'the things that are primary and common'. What does Aristotle mean by the 'proper attributes'? What is the sense of *pathē* here? Since Aristotle is dealing with the kinds of things considered by a science, and science deals with timeless and eternal relations and predication, *pathē* cannot here have its non-technical sense of what something undergoes or experiences. It therefore has the more general sense of 'attributes'. Aristotle is discussing how to scientifically study certain attributes of the subjects of the sciences. But Aristotle carefully distinguishes two different sorts of such attributes. Does Aristotle have in mind a) the demonstrated attributes, the *kath' hauta sumbebēkota* (*APo.*, 1.7 75a42–b2, *Meta.* Δ.30 1025a30–32)? Or b) is he discussing the definitional attributes of a subject? These are dealt with in very different ways by the science that studies them. Those attributes which Aristotle sometimes calls the *kath' hauta sumbebēkota* are demonstrated. Attributes which are included in a thing's essence and are expressed in definitions are grasped through *noēsis.*

As Ross points out,[12] it would be very odd for Aristotle to use *pathē* to refer to definitional attributes. Rather, within the *Posterior analytics* he uses the term to refer to the *kath' hauta sumbebēkota* (1.7 75a42–b2, 1.9 76a12–13, 1.10 76b15–16); this strongly suggests that 2a is the correct alternative. But this has been the minority view, probably because of the difficulty in developing on its basis a cogent interpretation of the paragraph as a whole. Many commentators have found 2b to be more promising, and they read this line as part of Aristotle's general account of how to secure the definition of a species through collecting and organizing a set of definitional attributes.

3) What are the primary, common things that are the basis of a science's consideration of the aforementioned *pathē* ? Four main alternatives present themselves.

a) The most natural sense of *prōta* is 'first' in the sense introduced at 1.2 71b21: most basic in the order of both causation and explanation. At least part of what Aristotle is saying would be the familiar point that a scientific account of a certain feature of reality must rest on first principles, concerning which there can be no similar account. But then what does Aristotle mean in referring to *common* first principles? Aristotle elsewhere (1.10 76b14–15, 1.32 88a36–38) calls those principles 'common' which apply to subjects falling under more than one

[11] Not much hangs on what we take to be the referent of 'this' (τοῦτο) at 96b19, since both possible referents (division into atoms and defining the atoms) are said to belong to the first stage of a science's treatment of its subject matter, preceding the study of the attributes of these atoms.

[12] Ross (1949), p. 658.

genus. He has in mind both principles which apply to all beings, no matter what the genus (such as logical principles, cf. 1.1 71a13–14) and premises which apply across genera, but not to all beings (as the laws of proportion apply to both numbers and magnitudes, but not to other beings, such as raccoons or stones (1.10 76a37–b2). Aristotle sometimes (1.2 72a16–18, 1.10 76b14) calls such principles 'axioms'. They are indemonstrable, and as such are first principles.[13] One problem is that it is very unclear why Aristotle would identify these, as opposed to other principles (such as the definitions of the species that form the subject matter of a science) as the principles that form the basis of a science's investigation of the *pathē*. Waitz and Barnes speculate that Aristotle takes the axioms to have different instantiations, depending on the kind in question.[14] So in saying that the investigation of the *pathē* on the basis of the axioms follows ascertaining the genus of the subject of the *pathē*, Aristotle is saying that one needs to determine which instantiation of an axiom is going to be operative, prior to its application. On this account, Aristotle is not neglecting the importance of other first principles; he is simply explaining that because common axioms are among the first principles that form the basis of one's demonstrations, it is vital to determine exactly to what category one's subject belongs, for otherwise a proper application of axioms would be impossible.[15] In my view, however, this line of interpretation is voided by the sentence that follows (96b21–25), which stresses the central role of *definition* in demonstrations and is introduced by γὰρ, which indicates that what follows gives the reason for what precedes. It is not clear why the importance of definition as a first principle of demonstration sheds light on how it is that within the context of scientific explanation a common axiom needs to be specified as applicable to a single subject.

b) Hence we are led to seek an alternative interpretation, according to which πρώτα refers to first principles, but κοινά has some other sense. Pacius provides such an interpretation: Aristotle is referring to certain premises employed in all of the demonstrations that belong to a certain science. But what are such premises? Every demonstrable proposition concerning a subject rests at least implicitly on the definition of that subject, and all subjects dealt with by a single

[13] Barnes (1994), p. 243 argues that on this account the qualification of the axioms as 'first' is otiose, and that this calls this account into question. As an anonymous reviewer points out, Aristotle may have added (πρώτων) merely in order to remind the reader of the common principles of Book 1, since he had not mentioned them for some time.

[14] Waitz (1846), pp. 415–416; Barnes (1994), p. 243.

[15] Cf. 1.10 76a42–b2, where Aristotle states that an axiom is employed only insofar as it is applied to the kind in question. This could be understood as an indication that, because of the strictures of Aristotelian syllogistic, the subject of the axiom must be the kind under consideration, not any conjunction of kinds or all beings. However, it is not clear at all how axioms such as logical laws can be accommodated by the syllogistic. Principles such as the law of the excluded middle are not of the form S is P that Aristotelian syllogistic demands.

science include in their definition the definition of the genus under which they fall. So there is a sense in which the definition of the genus that is the subject matter of a science is included in the premises of every demonstration falling under the science devoted to that genus. For example, the definition of 'animal' would be at least implicit in every zoological demonstration. But Pacius takes another tack. He distinguishes between the primary and composite subjects considered by a certain science. The common, primary things are those principles that are common to the attributes of both primary and composite subjects.[16] One who advocates this interpretation has the burden of proof to show that Aristotle did in fact distinguish subjects in this way.

c) Earlier in 2.13 Aristotle has been discussing how one is able to attain precisely expressed definitions of kinds. Sense can be made of 96b15–25 in context. On this account, Aristotle imagines collecting all of the possible differentiate that fall under a certain genus to which a kind S belongs. One then sees which of these differentiae belong to the kind in question, and which hold of all members of higher genera. Accordingly, the common things to which Aristotle refers might be those attributes common to all of the kinds falling under the genus; this tells us that these will be present in the definition of that genus. But, as Barnes points out, on this interpretation it is again unclear what the sense of πρώτα is.[17]

d) At 96a32 Aristotle refers to the first point at which the differentia in question and its genera are coextensive with a kind in question. So in context with what precedes the term would seem to refer to the specific attributes, not the generic ones. So one conceivable interpretation (though one that I have not seen advocated) is that the common primary things are the definitional attributes of the infimae species. To say that the *pathē* are investigated on their basis is to say that they are considered from the standpoint of the definitions of the infimae species. Hence on this interpretation Aristotle is making substantively the same point as in 3b, though the crucial terms are given a different sense. This interpretation, however, also fails explain the term πρώτα.

4) Aristotle concludes the paragraph by telling us that the reason that the attributes of the complexes are made clear on the basis of definitions[18] is that only simples are subjects for attributes that belong *kath' hauta;* the things belong to subjects that are not simple do so by virtue of the subjects that are simple.

What does Aristotle have in mind in referring to attributes which belong in themselves *(kath' hauta)?*

[16] Pacius (1966), pp. 334–335.

[17] Barnes (1994), p. 243

[18] Which definitions? Concievably Aristotle has in mind the definitions of the composites; Aristotle would be saying that even when a subject of an attribute is complex, the definition of that complex is the basis on which that attribute is explained. But this does not allow us to make sense of what follows, Aristotle's insistence that the simple is the principle of everything. Accordingly, all of the major interpretations of the passage (discussed below), different as they are, understand definitions as referring to the definitions of the simples.

Kath' hauto is a notoriously ambiguous technical term, to which Aristotle devotes several analyses. Of all of the many senses that Aristotle gives the phrase, only two seem possible candidates here. In both cases, if S is P *kath' hauto,* P is predicated of S on account of (*kata*) what S itself is. A predicate is *kath' hauto* i) infosar as it is caused or explained by the essence of its subject (1.473a34–7), or ii) it is *kath' hauto* insofar as it is caused or explained by the essence of its subject (that is, it exists *kata* the subject), and hence can be demonstrated of it.[19] The term I have thus far rendered 'predicated' is a participial form of sumbainein, a verb which is likewise ambiguous. Although Aristotle rarely uses this term in this sense, the verb with the dative can have the general sense of 'the be an attribute of', with no implications concerning the conceptual or logical relation between subject and predicate.[20] According to this sense, there is no reason why a definitional predicate cannot be said to sumbainein kath' hauto of its subject. On the other hand, '*sumbainein*' in Aristotle often has the connotation of that which happens to befall something, that is, what is predicated in a manner which is not necessitated by the nature of the subject (what is not predicated *kath' hauto* of the subject). Thus understood, *ta sumbebēkota* (the plural neuter perfect participle) is often rendered as 'the accidents'. Hence, one of the senses of 'accident' is that which is not *kath' hauto,* in sense i) above, that of being included in the definition of the subject (*Apo.* 1.473b4–5). Aristotle employs this sense of *sumbebēkos* when he employs the seemingly oxymoronic term *kath' hauta sumbebēkota* to denote those attributes which are accidental in the sense of not inhering in the definition of the subject, but are *kath' hauta* in the sense of following from the definition of the subject (*Meta.* Δ.30 1025b30–34). Although Aristotle commonly employs the perfect participial form *kath' hauta sumbebēkota* as a technical locution, the present phrase *ta sumbainonta kath' hauta* is very close, and, though Aristotle's technical terminology does not require this, one could well take the two phrases to be synonymous.

Accordingly, there are two major interpretations that can be given to *ta sumbainonta kath' hauta.*

a) *Kath' hauto* can be given the sense of 'definition'. If we take that option, *sumbainein* cannot have the sense of 'to be predicated of accidentally' for according to no sense of 'accidental' is a definitional predicate accidental. On this understanding, Aristotle is referring to the attributes which enter into a definition of a term. Aristotle would be making the point that the terms which enter into definitions of complex terms are restricted to those which enter into the definitions of simple terms. This interpretation finds its strongest support in the fact that it gives to Aristotle a sensible conclusion to what precedes (given that we interpret *pathē* as definitional attributes) and that Aristotle proceeds to concern himself

[19] This latter sense is the sense in which such a *kath' hauto sumbebēkos* is *kath' hauto*. Although Aristotle uses this locution within the *APo.,* it is not clear whether this sense is isolated and discussed as such in this work.

[20] See LSJ s.v. II. 5.

with collating and organizing the attributes which are present in the definitions of the kinds that are studied by a science (96b25–97b25).

b) On the second interpretation too the *pathē* and *ta sumbainonta kath' hauta* are taken to be the same thing, but here they are both taken to be demonstrable attributes, as opposed to definitional ones. The linguistic similarity between *ta kath' hauta sumbebēkota* and *ta sumbainonta kath' hauta* strongly suggests that Aristotle is saying that the demonstrated attributes that a science considers are primarily inherent in the simple subjects considered by a subject, and belong to other subjects via the intermediacy of these simple subjects.[21] On both interpretations, Aristotle is saying that, although we predicate such terms of complexes, they nonetheless exist not *kata* the complexes but *kata* the simples (the referent of ἐκεῖνα).

To review, the major interpretative options are as follows:

1. What does it mean to divide the kind under consideration into the primary atoms in respect to the kind?
   a) The systematization of a science requires dividing the genus treated by that science into its infimae species.
   b) The systematization of a science requires distinguishing between the primitive and derived terms employed in the technical discourse of that science.
2. What are the proper attributes, which are studied through the things that are primary and common?
   a) They are the demonstrated attributes, the *kath' hauta sumbebēkota*.
   b) They are the definitional attributes of the species that make up the subject matter of a science.
3. What are the things that are primary and common, by means of which one studies the proper attributes?
   a) They are the common axioms, first principles shared by a number of sciences, but in the context of demonstration, instantiated in regard to the subject genus under consideration.
   b) They are those first principles that are ultimate premises for the demonstrations of the attributes of both the simple and the composite subjects of a science.
   c) They are the definitional attributes of the genus, which are common to all of the species that fall under the subject genus of a science.
   d) They are the definitional attributes of the infimae species that fall under a genus.
4. What are the attributes that belong in themselves to the simples alone?
   a) They are the definitional attributes of the infimae species studied by the sciences.
   b) They are the *kath' hauta sumbebēkota* of these species.

[21] See Ross (1949), p. 658.

4.

An interpretation of this difficult passage must be assembled from these various options. It must meet the constraint of making one or more points consistent with the demonstrative theory sketched elsewhere in *APo*. Two more features of an interpretation would strengthen it. Aristotle ought to be making an interesting point, and the point ought to make some sense in its present context (though the *Apo.* is full of parenthetical notes that do not seem to be placed where they are for any clear reason).

The following are the major interpretations in the literature.

The interpretations of Philoponus,[22] Themistius,[23] Eustratius,[24] and Tricot[25] rest on making the following exegetical choices: 1a, 2b, 3c, 4a. On this account, Aristotle is here primarily concerned with determining the definitions of the infimae species that fall under a certain genus. This requires collating definitional predications, seeing which are common to which species. For Philoponus and Eustratius, the infima species is what is simple, and the genus is what is complex, insofar as the genus is an assemblage of all the species. In saying that the attributes of the complexes have as their basis the attributes of the simples, Aristotle is understood to be saying that the definition of the genus is arrived at through collecting and organizing the attributes common to all of the definitions of the species. Ross calls this interpretation that of 'most of the commentators'.[26] We have seen that he rejects this on account of the unlikely sense given to *pathē,* he also objects that Aristotle is unlikely to have considered the genus a complex in regard to the species, and that what follows (96b25–97b6) concerns the definition of species, not genera.

Waitz opts for 1b, 2b, 3a, 4a.[27] On this account, too, Aristotle is discussing the search for the definitions of the kinds falling under a genus. We begin by assembling the terms which enter into these definitions; these terms are the 'simples', while τὰ συντιθέμενα ἐκ τῶν ἀτόματῶν are the indivisible species. The definitions at which one arrives will be employed in demonstrations, with the aid of the common axioms, understood as applicable to the kind at hand. These definitions are complexes which are studied on the basis of the simple terms that make them up.

Pacius makes these choices: 1a, 2a, 3b, 4b. Ross mostly follows Pacius and chooses as follows: 1a, 2a, 3c, 4b. Aristotle on this account says that a genus is studied scientifically through first determining the infimae species that fall under that genus. For it is on their basis, we are told, that we gain scientific understanding of

[22] Philoponus (1909), pp. 400–403

[23] Themistius (1900), pp. 56–57. Themistius's paraphrase here is selective. While the other commentators are more explicit, one must infer Themistius's take concerning 2b, 3c and 4a on the basis of consistency with points which he explicity addresses.

[24] Eustratius (1907), pp. 191–98.

[25] Tricot (1979), pp. 215–216.

[26] Ross (1949), p. 657.

[27] Waitz (1846), pp. 415–416

the *kath' hauta sumbebēkota.* This scientific understanding comes about through demonstration. On Pacius's account, Aristotle explicitly identifies the principles concerned with a science's primary subjects as forming the basis of these demonstrations. Ross tells us that these demonstrations will have as their basis 'the primary attributes common to the primary and complex species',[28] This shows that Ross opts for 3c, though it is unclear what Ross thinks Aristotle means by the *primary* attributes.

Barnes expresses puzzlement with the passage. He sees advantages to both 1a and 1b. He takes 1b to be the most promising option at 96b21 but rejects it as ill suiting the examples of triad and dyad at 96b17. On the other hand, Barnes argues, if we identify *ta koina prōta* with the atoms, we are unable to give a good sense to 96b19–21. Barnes likewise straddles the fence in regard to issue 3. He favors 2a and 4b, and despairs at putting all of these pieces together into a single coherent interpretation.

Detel opts for 1a, 2b, 3b, and 4b. Detel takes the passage to be part of the general discussion concerning division; hence he is led to take the *pathē* which are being investigated to be definitional attributes. He recognizes however that the end of the paragraph concerns the use of basic definition as first principles in demonstrating *kath' hauta* predications. Consequently the philosophical point he takes the passage to be making is similar to that of Pacius. But he does not follow Pacius in taking the text to reflect a distinction between basic subjects and those 'composed' of them in any straightforward way. In *Explaining an eclipse,* I have argued that it is just such a distinction between simple and derivative subjects that enables Aristotle in 2.8–10 to account for how the attributes and events most important to science are to be explained through strict syllogistic deduction from definitions. Below, I briefly scketch how this is so, and how I take this teaching to be reflected in the present passage. Detel on the other hand raises the problem of how non-definitional predications can be deduced syllogistically from definitions only to abandon it as insoluble. Rather, he takes the definitions and the divisions from which the definitions are derived to merely provide a background theory that provides the context from which these attributes and events can be accounted for in a looser, non-syllogistic manner. He takes the present passage to be pointing to the role indemonstrable predications play within such a background theory.[29]

The interpretation that I advocate is similar to that of Pacius; I too opt for 1a, 2a, 3b, 4b. I precede my own account with a response to objections that are raised against an account such as that of Pacius.

5.

Among major commentators, Barnes alone has presented an argument against Pacius's interpretation. He makes two points. The first misunderstands Pacius's

[28] Ross (1949), p. 658.
[29] Detel (1993), Vol. 2, pp. 756–761.

point; the second is successful against Pacius but not against my adaptation of Pacius's account.

Barnes first focuses on point 1a. As we have seen, for Pacius the atoms are those infimae species on the basis of which other kinds are built, as all of the other numbers are built up from the dyad and triad. Barnes's objection does not focus on the murkiness of the mathematical details. Rather, he suggests that while, on Pacius's account, Aristotle makes a point concerning the definitions of a specific variety of inifmae species (that which is the foundation of certain complexes), Aristotle 'gives every appearance of making an entirely general point'.[30] But Aristotle could still be construed as making a general point. The generality is not in regard to all of the subjects of a science, but in regard to all of the sciences. This is because, as I have suggested, all sciences are such as to admit the distinction between simple and derivative, composite subjects, since there is no real distinction between derivative subjects and demonstrable attributes.

Barnes's second objection is that Pacius's interpretation has Aristotle making a patently false point—that the attributes of the compounds are attributes of the simples—that is, that 5 has the attributes of 2 and 3. This objection is especially effective if one takes Pacius to be attributing to Aristotle the view that any attribute of a composite subject must be an attribute of *all* of the simple subjects of which it is composed. But Pacius does not make such a strong point, nor is there support in the text for attributing it to Aristotle.[31] Rather, Aristotle is most plausibly read as making the claim that every attribute of a composite subject belongs to at least one of the simple subjects of which it is composed. Admittedly, this point does not hold in regard to Aristotle's arithmetical example. It is not the case that every attribute of a number belongs to at least one of the simple numbers that make it up additively, though a stronger case can be make if the numbers that make up a complex number are its factors[32] (provided that the simples are not only 2 and 3 but all prime numbers).[33] At any rate, here as elsewhere, the obscurity of the details of a mathematical example that Aristotle presents is not sufficient warrant for rejecting an account of how Aristotle's account of scientific explanation squares with the mathematical details to which it is applied.

But what could Aristotle mean by suggesting that any attribute of a complex subject is an attribute of at least one of the simple subjects involved? Does such a claim make sense in the context of Aristotle's theory? This is the last issue to which I turn.

[30] Barnes (1994), p. 244.

[31] The plural τοῖς συντιθεμένοις τῶν ἀτόμων, and τὰ συμβαίνοντα at 96b21–22 are not sufficient at evidence for taking the attributes of the composites to be derived from the attributes of all of the simples, since Aristotle is here speaking collectively of the relation holding between all the *pathē* and all of the simples.

[32] See for example, Plato, *Theaetetus* 147e–148b and Euclid, *Elements* Book 7, Definitions 6–11.

[33] Note that the term for 'prime' is *prōtos*, the same term that is usually rendered 'primary', by which Aristotle, in the present passage, refers to the simple subjects of the sciences.

6.

I begin with what I take to be the Aristotle's understanding of the distinction between simple and complex subjects studied by the sciences. I present this without supporting argument, for which I refer the reader to *Explaining an eclipse*.

Aristotle takes the objects of scientific understanding to be propositional, that is, they are expressed in *logoi* in which one term is predicated of another. Scientific understanding of a proposition comes about through showing how it follows syllogistically from first principles. Among these are definitions, which express the essences of things. These essences are simple entities. Although a definition which expresses an essence is propositional in form (the *genus* and the *differentia* are attributes, and the *definiendum* is the subject), the subject and attributes all denote the same thing. (The *genus* points to basic features of the kind of which the thing belongs that are shared with things that belong to certain other kinds, but contra Plato neither the kind nor the features are things unto themselves.) Hence the subject is a simple, the definition of such a subject is a simple, and the *noēsis* by which one apprehends the subject in a scientific manner is correspondingly simple, however complex the process leading to that apprehension might be. Such subjects comprehend both infimae species and their *genera* (pace Philoponus and his followers); excluded are derivative, complex subjects whose definitions are not assumed among the first principles of the sciences, although the *meaning* of the terms that denote them is assumed (1.1 71a12–16, 1.10 76a5–11).

There are two ways in which a proposition can be demonstrated. First, the demonstrated attribute may be what I have called 'implicitly definitional', either present in the definition of a subject, or present in a definition which is present in the definition of a subject, and so on. The demonstration of such predications merely render explicit *genus*/species relations. They are a matter of a straightforward application of the syllogistic form Barbara, but there are few interesting propositions which can be so demonstrated.[34] Second, Aristotle claims that one can show how certain features result from simple subjects standing in certain necessary relations with one another. To employ Aristotle's own examples, in investigating thunder we consider the nature of fire as juxtaposed[35] with that of cloud; when these stand in the appropriate relation, there is the quenching that leads to a certain noise that we identify with thunder, an identification that is expressed in a

[34] Since McKirahan takes all demonstrations to be of this sort, he argues that all demonstrated attributes are definitional, and therefore argues that in addition to the form of definitions as genus + species, there is at work in *APo*. the notion of a 'fat definition' which is a conjunction of all definitional attributes. See McKirahan (1992), pp. 111, 119–120, 168–169. But the notion of such 'fat definitions' is absent from the text.

[35] I use the term 'juxtaposed' for a number of different relations: that holding between two and three in making five, that holding among the lines of a triangle, that holding among astronomical bodies during an eclipse, and so on. I do not offer a single unifying formula for this relation, and do not believe that Aristotle has a single variety of relation or concatenation in mind. In every case, though, there are simple subjects that stand in a relation to one another from which some attribute or event necessarily follows.

nominal definition of thunder. Likewise, in investigating an eclipse we determine the optical phenomenon that results when the moon, earth, and the sun's light stand in certain periodically necessary relations. It can be scientifically shown that when these relations hold there results a certain kind of blockage of light from the moon which, again, is identified with an eclipse in a nominal definition (*APo*. 2.8 93al6–b14).

There is a categorical distinction between the relation in which one subject stands in, regard to others, and an event or attribute that follows from it. Both a certain juxtaposition of moon, sun, and earth, on the one hand, and the blockage of light, on the other, stand in the category of relation. But from the point of view, not of metaphysics, but of the theory of demonstration, a juxtaposition or relation that constitutes a complex subject is merely a kind of attribute predicated of a simple subject. A demonstrated attribute such as thunder or eclipse may be referred to by a noun, and such a noun has a definition, in a sense, but one who has a scientific understanding of such an attribute recognizes that it is indeed an attribute, grasps the subject of which it is an attribute, and explains, on the basis of first principles, why it is an attribute of that subject. Thus the attribute of being eclipsed is the conjunction of certain perceptible, recognizable features that necessarily follow the attribute of standing in a certain relation to other astronomical bodies. To turn to one of Aristotle's biological examples (*APo*. 2.16 98b16–38), shedding is the attribute of having dead leaves fall from a plant's living stalk, which necessarily follows the juxtaposition which, from the biological point of view, is the drying of sap at the juncture of the leaves and stalk and, from the point of view of chemistry, is the detachment of an earthy thing from another, elevated earthy thing.[36] Aristotle takes this scheme to hold even in the mathematical realm; a certain feature of a side of a triangle (an attribute of a line) necessary follows from what we know about the triangle of which it is a side, and this triangle in turn is a juxtaposition of lines, which from another point of view can be considered as an attribute of a line on which it is constructed.[37] So although, as we have seen, it is obscure how attributes of all numbers are to be understood as attributes of the simpler numbers, things are simpler in the case of Aristotle's other examples. Shedding is properly speaking an attribute of earth, and eclipse, of the moon. To say that 'having the sum of the interior angles equal to two right angles' is a predicate of a line is to say that every line is such that, when lines are drawn from its endpoints to some point outside the line, that line adjoins two angles that, when added to the angle that subtends that line, equal two right angles.[38]

Except in *logos* (how we talk about it), such a juxtaposition is not a thing unto itself, apart from whatever predications result from it. Unlike the subjects which stand in relation to one another, it has no inner principle of unity. The fact that it

[36] See Goldin (1996), pp. 139–147.

[37] See Goldin (1996), pp. 58–61, 129–134.

[38] Again, understanding Aristotle's mathematical examples as of the form S is P is more forced than Aristotle realizes. My interpretation is not alone in having problems reconciling Aristotle's geometrical examples to the syllogistic demonstrative form in which he presents his analyses.

occurs with necessity and with some regularity derives not from the nature of just one of the natures involved, but from all of them, in relation to each other. Accordingly, the world will be full of such periodically occurring complexes, juxtapositions, and relations, some eternal (for example, the sun, perpetually in orbit around the earth, entails that the sun always shines on the earth), some periodic (such as eclipse), and some occasional (such as thunder). Which ones are considered significant enough to be of special attention to the sciences, or even worthy of denotation by a single term, is to a certain extent a matter of convention. Put another way, events such as eclipses, blasts of thunder, and sheddings of leaves (or, for that matter, the potentialities for these) are not natural kinds, but are conjunctions of attributes whose inherence in certain natural kinds (the 'simples') is to be explained on the basis on the principles of the sciences.

So how exactly are the natures and consequences of such juxtapositions and events revealed through demonstration? When a nondefinitional attribute P is predicated of a simple subject S, this is because S is considered as standing in a complex relationship with other simple subjects (S_1, S_2, etc.) in such a way that there is predicated of S a conjunction of attributes, each of which is definitional of one of the subjects involved (for example, P, definitional of S, P_1 of S_2, and P_3 of S_3). A nominal definition identifies some predicate Q with the conjunction of subjects or attributes definitional of subjects (say P, P_1 and P_3). For example, if a nominal definition of thunder is 'a certain noise in the clouds', this is a conjunction of definitional primitives of acoustics, which defines noises as such, and meterology, which defines clouds (where I take it that this nominal definition leaves unstated the true *subject* of acoustics, air).[39] There are three kinds of propositions that can serve as premises of a demonstration that S is Q. The premises can be definitional. Alternatively, a premise can identify one subject with another subject. For example, in the case of the demonstration that the moon suffers an eclipse, the moon, a subject of astronomy, is identified with an opaque body, a primitive of optics. Similarly, in the demonstration that certain plants shed their leaves, the leaves, a (part of) a primitive of botany, is identified with an earthy body, a primitive of physics.[40] A third premise posits a kind of accidental juxtaposition whose occurrence is occasional. In this case, one subject is identified as located at or otherwise related to some other subject. For example, the demonstration that clouds (sometimes) thunder must rest on the premise that clouds are sometimes conjoined with fire.[41] Accordingly, no terms will be present in the demonstration

[39] Again, the logical details remain unclear. For thunder in this case we do not have a strict conjunction (for thunder is not a cloud that is also a noise) but is rather a conjunction of 'noise' and 'in the clouds'. To show by means of Aristotelian syllogistic that there is such a thing as to instantiate this conjunction is not a straightforward affair. But again, the present passage seems to predate the application of syllogistic theory to Aristotle's demonstrative theory, and the difficulty of such an application does not speak against the interpretation I here offer.

[40] On this see Goldin (1996), pp. 148–151.

[41] For a detailed discussion of how this and other demonstrations discussed here are accounted for in *APo*. 2.8, see Goldin (1996), pp. 101–137.

that is not either a subject term, a term definitional of some subject term; or a term which through a nominal definition denotes some conjunction of the above two kinds of terms. Any feature or predicate that results from the juxtaposition of two simple subjects must be analyzable as a conjunction of attributes that are definitional of the respective subjects. Were this not so, this new feature would be emergent as a whole greater than its parts, and this juxtaposition would itself have the role of being a simple subject.

We see that on this understanding a derivative subject is not a thing unto itself, but is an attribute predicated of a basic subject, the attribute of standing in a certain relation to other subjects, a relation which necessarily entails certain other features and attributes of that subject. Hence if one demonstrates that the simple subject stands in the complex relation to other subjects, it can be demonstrated that the features in question are likewise predicated of these subjects. Although ontologically speaking, there is a distinction between a relation, on the one hand, and, on the other hand, the actions and attributes that necessarily follow from it, within Aristotle's theory of demonstration, what McKirahan (1992) calls a derivative subject (whose existence is proven, not assumed) has precisely the same status as a demonstrated attribute (what Aristotle calls a *kath' hauto sumbebēkos*). To prove the existence of a derivative subject is to show that a simple subject stands in certain relations to others. Likewise, demonstrating that a nondefinitional attribute holds of a simple subject requires the same thing: showing that the subject stands in certain relations to other simple subjects, which entail certain consequences identified as constituting the attribute in question. Because the 'what it is' is the 'why it is' (*APo*. 2.2 90a7–15) the attribute of being eclipsed *is* the interposition of the earth between the sun and moon; thunder *is* the situation in which fire, water, and clouds stand in the appropriate relation.

We turn back to the second of Barnes's objections against Pacius's interpretation: that it would have been patently false for Aristotle to have maintained that the attributes of derivative, complex subjects are those of the simple subjects that make them up. The first step in answering this question is to become clear on what a complex subject is, and what role it has in Aristotle's theory of demonstration. I take such a complex subject to be what I have been calling a juxtaposition of simple subjects, or a derivative subject. An attribute of a complex subject, then, would be an attribute of an attribute of a simple subject; and it is such attributes which, at some level, are to be identified with the attributes of the simple subject. Accordingly, in one sense the attribute of a complex subject falls under the genus that constitutes the subject of the science that studies the complex. But it does not stand to that subject in the relation of a species to its encompassing genus.[42]

[42] As an anonymous referee for this journal puts it, 'There are good reasons to suppose . . . that the single *genus* with which a science is concerned "number" for arithmetic, "magnitude" for geometry) is not related to the things in it (individual numbers, perhaps, for arithmetic, straight lines, circles, etc. for geometry) in the way that a *genus* in the other sense, ("bird" for example) is related to the species that fall under it.

The second step is to become clear on what it means to say that an attribute of an attribute of a subject is itself an attribute of a subject. What is an attribute of an attribute? Aristotle's ontology requires that an attribute of an attribute simply be an attribute with a specification; there is no room in the scheme of the categories for adverbs as such.[43] Thus brightness of color is simply color, further specified: bright color. To turn to examples familiar from Aristotle's treatment of demonstration, the time or extent of the eclipse is properly speaking, an attribute of the body that is undergoing the eclipse. To say that the solar eclipse is total is not, properly speaking, to predicate totality to the eclipse, but to predicate a total eclipse of the sun. Accordingly, to demonstrate that a certain periodically occurring eclipse is total is not to predicate one attribute, totality of another attribute, being eclipsed. It is rather to predicate of the sun a single attribute, being totally eclipsed.[44] Likewise, to predicate being right of a triangle is simple to predicate of one of its sides being at right angles to another side. Each of these attributes is, as we have seen, a conjunction of predicates that are definitional of simple subjects. Thus Aristotle tells us that being at right angles is definitional of a line (though Euclid takes right angles to themselves be simples whose definition and existence are assumed; see *Elements*, Book 1, Definition 10) and 'the predicates belong in themselves to the simple alone, and to the other things on account of them'. (*APo*. 2.13 96b23–25). That is to say, the attribute of a complex subject (that is, an attribute of a certain kind of attribute) is, in effect, a definitional attribute of a simple subject. It can be considered to be an attribute of a complex subject only by virtue of the definitional relation that the components of this attribute have to the simple subjects of the sciences. Aristotle says that this allows us to make sense of the fact that, even as so specified, these attributes are demonstrated on the basis of the definitions of the simple kinds that constitute the subject matter of the science. This is what Aristotle means when he says 'the attributes of the complexes built from the atoms will be clear from the definitions'. (*APo*. 2.13 96b2)

7. Conclusion

I conclude with a rendering of 96b15–25 which supplies what Aristotle's terse Greek leaves out, and presents the meaning of the passage as I understand it.

> When someone is dealing with the whole body of facts dealt with by a science, one must begin by dividing the genus into the infimae species. For example, in order to approach the task of working through the science of arithmetic as a whole, one must divide the genus number into the species triad and dyad, and then in this way one must try to get a handle on the definitions of these two species. To take another example, in working through the science of geometry, one

[43] See Goldin (2002), p. 244.

[44] In *APo*. 2.8 Aristotle sketches how it can be demonstrated that the moon has all of the sun's light blocked from it, which attribute *is* the total eclipse.

must try to get hold of the definitions of straight line, circle, and right angle. This whole process involves determining the category in which the subject genus falls, for example, whether it is a quantity or quality, since this category is going to need to enter into the definition of all of the species that fall under this genus. After this process is completed, one must study the demonstrated attributes by showing how they logically follow from the first principles which pertain to all items in the genus that the science studies. For the attributes of the subjects that are derivative from the infimae species, which are those predicates that are *kath' hauta sumbebēkota* of the basic subjects, will be clarified (that is, their inherence in these subjects will be explained) on the basis of the definitions of those infimae species. This is true for two reasons: 1) the definition of the simple kinds is the first principle of all of the other facts with which that science is concerned, and 2) the attributes are *kath' hauta* in relation only to the simple things (i.e. the infimae species); attributes are predicated of things that are not simple (that is, attributes or complex subjects) on account of those simple things, that is, from being deducible from the definitions of the simples.

Acknowledgements

I owe thanks to Arun Iyer for editorial help, to Richard Tierney for comments and discussion, and especially to an anonymous referee for this journal for suggestions and questions.

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